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ABSTRACT

This study qualitatively examines teacher intentions to utilize national standards as a resource for reform in their classrooms, schools, or districts. The topic is explored in light of recently adopted state guidelines called the Texas Essential Knowledge and Skills (TEKS) in science. The effect that state guidelines have on teachers' professional commitment to the principles of the national standards and their intention to implement and support the systemic changes outlined by the national standards is also explored. The questions that guide the research relate to the beliefs and attitudes of teachers regarding the recommendations of national standards documents; teacher attitudes toward the necessity of national standards for reforming science education in their classrooms, schools, and districts; and the factors that influence teacher intentions to utilize national standards as a tool for reforming science education. Contains 19 references. (DDR)

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National Standards in Science Education: Teacher Perceptions on Utilization

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Introduction

> Some outstanding things happen in science classrooms today, even without national standards. But they happen because extraordinary teachers do what needs to be done despite conventional practice (National Research Council, 1996, p. 12).

We all know this to be true. Many of us in science education chose to become teachers because we were influenced by one of the extraordinary teachers mentioned above. But we also know that if the quality of our children's educational experiences in this country is to change significantly, we cannot rely simply on one or two extraordinary teachers in each school to make that change through sheer force of personality. Every teacher must buy into the principals and techniques that those extraordinary few are already implementing. And all of these teachers must believe that the risks they take in order to improve science education in their classrooms, schools, and districts will be supported by policies and practices throughout the system (National Research Council, 1996). With the advent of national standards initiatives such as the *National Science Education Standards* from the National Research Council (1996) and Project 2061's *Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1993), we can speak a common language regarding high quality science education and begin to describe the criteria we can use to judge practice both on an individual and system-wide level.

Now that these documents have been published however, the question becomes, will the typical classroom teacher utilize them? Further, what factors are most likely to influence the classroom teacher in their decision to utilize or ignore national standards?

The purpose of this study is to qualitatively examine teacher intention to utilize national standards as a resource for reform in their classrooms, schools, or districts. Specifically, this topic will be explored in light of recently adopted state guidelines called the *Texas Essential Knowledge and Skills*, or *TEKS*, (Texas Education Agency, 1998) in science. Particular attention will be placed on what effect, if any, state guidelines may have on teachers' professional commitment to the principles of the national standards and their intention to implement and support the systemic changes outlined by the national standards as necessary for science education reform.

The following research questions guided this investigation.

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1. What beliefs and attitudes do teachers hold regarding the recommendations of national standards documents such as *NSES* and *Benchmarks*?

2. What are teacher attitudes regarding the necessity of national standards for reforming science education in their classroom, school, or district?

3. What factors influence teachers' intention to utilize national standards as a tool for reforming science education in their classroom, school, or district?

4. What impact do state mandated guidelines have on teachers' intentions to utilize national standards as a resource for reform?

Background

National standards projects such as the *NSES* and Project 2061 differ from the reforms of the past with their emphasis on systemic change. While the *NSES* and Project 2061 have approached systemic reform from different angles, each asserts that a simultaneous restructuring of all aspects of the educational delivery system is a prerequisite for long-lasting change. Now that these programs have helped to define the revisions that need to occur, the obvious question many policy makers and practitioners are asking is, "Will significant changes follow in science classrooms?" The first step in answering this question is to assess the perceptions teachers hold about the national standards themselves as well as their opinions about the possibilities of implementation. Only after reaching an understanding regarding this issue will policy makers be able to determine the most effective course of action to achieve implementation.

In Texas, as in many other states, this issue is confounded by the recent adoption of a set of state mandated guidelines called the *Texas Essential Knowledge and Skills*, or *TEKS*. Although the framers of the *TEKS* relied in part on the Science Content Standards of the *NSES* and *Benchmarks* in developing their document, the *TEKS* differ from the national standards in many ways. The *TEKS* deal essentially with science content, not professional development, program standards, or system standards. Although this difference may appear to be subtle at first, it may prove to be quite significant in the context of long-term changes. Issues such as assessment and teaching standards are only dealt with indirectly in the *TEKS* by describing the type of content students should be experiencing. While the *TEKS* do not specify separate standards for assessment, they will be used to design a statewide accountability system of standardized testing for students in science some time in the future. This is the primary difference between the *TEKS* and the national standards. Teachers in Texas will be held accountable for adhering to the *TEKS* through

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standardized testing. This direct accountability does not exist thus far for the national standards. Some would argue that this lack of accountability in national standards will eventually doom them to educational ignominy like so many of the highly touted reforms that preceded them. Will teachers, faced with the far more immediate pressure to produce students that can perform well on state standardized tests, simply ignore the array of fundamental changes advocated by the *NSES* and Project 2061and focus only on the content of the *TEKS*? Or will they seize this opportunity to act as advocates for implementation of the crucial changes that the *NSES* and Project 2061 recommend in their classrooms, schools, and districts?

Seminal work done by Francis Fuller (Fuller, 1969) outlined the stages of concern that teachers go through when dealing with an innovation. The first concerns teachers will experience will be on a *personal* level. What is this innovation and what does it mean for me? Am I adequately prepared to meet the demands of the innovation? What will be the personal rewards or consequences for implementation of this innovation? Will I run into any potential conflicts with established structures or colleagues because of implementation? The next stage of concern deals primarily with *task and management* issues. Organization, scheduling, time management, and efficiency issues are all high priority at this time. The third major stage of concern is how will this innovation impact the *students*? Is it relevant and necessary? Will it improve learning in my classroom?

Work done by others with Fuller's stages of concern led to the development of the Concerns-Based Adoption Model (Hall, Wallace, & Dossett, 1973). This model indicates that implementation will be most successful if leaders and administrators deal with the personal concerns expressed by teachers at the initial stages of implementation before trying to convince them of the positive impact on students. As the implementation process proceeds, concerns of teachers will change and should be addressed as they come up. Therefore, the implementation strategy should be on-going and flexible enough to deal with these changing concerns. Change is a process and not an event. The typical one-time inservice at the beginning of a program will not be likely to address the changing needs of the teachers. This study will contribute to efforts by researchers to understand how teachers, the front line of any educational policy implementation effort, perceive national reform and how those perceptions affect their intentions to utilize national standards as a tool for reform.

Theoretical Framework

The advent of national standards in science education is a fairly recent phenomenon. Current theory offers no cohesive explanation for why some teachers choose to utilize national standards to guide their practice while others ignore them. This research begins to lay a foundation for constructing such a theory regarding standards utilization which is grounded in qualitative data.

Theory of Planned Behavior

Azjen's Theory of Planned Behavior (1985) framed the analysis of factors which influenced teachers to utilize the national standards. Put simply, this theory asserts that intentions to perform a behavior (such as using national standards as a resource for reforming practice) can be predicted from an examination of participant attitudes toward the behavior, subjective norms (social pressures to perform the behavior), and perceptions of behavioral control (personal confidence it their ability to perform a behavior). Crawley, Barufaldi, & Salyer (1994), utilized Azjen's Theory of Planned Behavior to study the knowledge, beliefs, and attitudes of a group of Texas middle school science teachers regarding implementation of a curriculum innovation termed Coordinated Thematic Science (CTS) in their classrooms. Researchers surveyed 29 teachers who had field tested Coordinated Thematic Science I materials in their classrooms to determine their commitment to implementing Science I instruction in their classes. The initial data indicated that teachers' attitudes toward the quality of the materials were a "significant predictor of their intentions to use the materials during the upcoming school year" (p. 245). However, further analysis of their data led the researchers to conclude that teachers' opinions of the value of the instructional materials, their perceptions of social support and their own qualifications to teach specific content areas (perceived behavioral control) all significantly impacted their decision to implement CTS. In contrast, Crawley (1990) stated that "teachers' attitudes toward investigative teaching, not their sense of social support or empowerment, solely determined whether or not they were committed to laboratory work". In addition, Crawley and Black (1992) determined that students' intention to enroll in a high school physics course was determined primarily by their perceptions of behavioral control and their attitude toward enrollment.

The varying degrees of influence that each of the three factors exert in determining an individual's intention to perform a behavior in all of these studies indicate that the factors' influences are context

dependent and idiosyncratic. Therefore, within the context of national standards utilization, TPB lends itself well to providing a framework for building grounded theory regarding the factors which influence an individual's intentions to utilize or ignore national standards documents.

While previous studies based on the Theory of Planned Behavior have generally utilized statistical means in this analysis, recent attempts have been made to apply qualitative methods to this framework as well (Crawley and Salyer, 1995). This research further extents the application of the Theory of Planned Behavior to the analysis phase of a naturalistic study.

Methodology

Overview

Given the lack of current theory regarding utilization of national standards, it was imperative that a phenomenological approach be applied to this study. Research techniques were designed to illuminate and explicate the perceptions of individual teachers related to national standards. In keeping with the basic tenets of naturalistic inquiry set forth by Lincoln and Guba (1985), this research (1) kept to a minimum the extent to which this phenomenon was manipulated in order to study it and (2) placed no prior constraints, such as predetermined response categories, on the data as it was collected. As a result, qualitative methods guided by a naturalistic approach and grounded theory techniques (Strauss and Corbin, 1990) were utilized in data collection and analysis in order to explore teacher perceptions of national standards documents such as the *NSES* or *Benchmarks for Science Literacy*.

The phenomenological doctrine of *verstehen* provided a theoretical perspective for designing methodology. Verstehen, which literally means "understanding", begins with the assumption that human beings have a unique capacity to make sense of the world. According to Patton (1990), "The verhesten tradition stresses understanding that focuses on the meaning of human behavior, the context of social interaction, an empathic understanding based on personal experience, and the connections between mental states and behavior. (pp. 56-57)" Many of these principles are similar to those of naturalistic inquiry laid out by Lincoln and Guba (1985).

Design decisions in a phenomenological study must then be based on the researcher's commitment to "*understanding* social phenomena from the actor's own perspective. . . . The important reality is what people perceive it to be" (Taylor and Bogdan, 1984, p. 2, emphasis in the original). This emphasis on participant's perceptions guided the methodological choices made throughout this study.

Participants

In order to focus on the context specific experiences of individual teachers, participants were chosen purposefully to represent varying degrees of exposure to the national standards. Purposeful sampling, a naturalistic technique which identifies key participants in order to explore individual differences in perspective (Patton, 1990), has two strengths which make it particularly useful in this study. First, through maximum variation sampling, detailed descriptions of a variety of individual participants and their perceptions can be developed. This is in contrast to the traditional experimental technique which attempts to control for any differences in participants and thus limits the researchers exposure to multiple facets of a study. This thick description allowed the researcher to pinpoint the unique characteristics of each participant which contributed to a broader, rather than more limited, understanding of a social phenomena. In Piagetian terms, "When diversity is dramatic, the knower is confronted by all sorts of novelty, which stimulates accommodation; consequently, the knower's cognitive structures become more integrated and differentiated; after novelty is confronted and accommodated, he or she can perceive more richly and, one hopes, act more intelligently" (Donmoyer, 1989, p. 191). As Donmoyer has stated, when viewed from the perspective of schema theory, the goal of research should be to "expand the range of interpretations available to the research consumer" (Donmoyer, 1989, p. 194), not merely to pinpoint the one correct interpretation. Second, maximum variation sampling adds significance to any common themes that cut across participants because these commonalties have arisen from cases purposefully chosen for the variety they represent along a particular continuum. In this study, that continuum is defined by the degree of exposure participants have had to national standards in science education (Patton, 1990).

Data Collection

Six teacher participants and one district level administrator all were involved in formal interviews. The six teacher participants all taught middle level science (grades 6-8) in Central Texas. Four of these teachers taught at a middle school in a district, Hadleyburg Independent School District, which was not involved in any type of systemic reform initiative. This middle school, Hadleyburg Middle School, or HMS, served as the primary case of study. The secondary curriculum coordinator in HISD was also interviewed in order to clarify the position of administrators in this district toward national standards usage as well as to provide an overall picture of efforts to redesign science curriculum. Two teachers in another Central Texas district were chosen as well to assist with negative case analysis. The district these teachers taught in, Morgan ISD, was involved in a major Urban Systemic Initiative in this state which provided both material resources and personnel to participating districts in order to reform science education programs. As working hypotheses arose from the data collection in Hadleyburg, these hypotheses could be explored with teachers in both districts in order to account for the effects extensive training in the national standards may have had on teachers. The teachers at Morgan Middle School, or MMS, also provided a perspective which assisted the researcher in exploring issues and testing ideas with the Hadleyburg teachers in follow-up interviews that had not been previously investigated.

Teacher participant interviews were the primary data collection method. A "generalized interview guide approach" (Patton, 1990) was used to collect data. In this approach, an outline of issues to be explored guided questioning of the participants but no formal standardized interview protocol was adhered to. Interview questions were open-ended and did not limit the responses of the participants to pre-established choices. This technique assisted me in conducting an interview which was responsive to the individual concerns and experiences of each teacher but which made data collection somewhat systematic for each respondent. Initial interviews were approximately one hour each. Interviews were audiotaped and transcribed. Follow-up interviews were conducted with each participant in order to clarify data analysis and further explore emerging themes. Member checking was employed both during the interview process through short summary statements and after data analysis through written summaries to insure that participants confirmed

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the researchers interpretations of their perceptions. Furthermore, some participants communicated with the researcher through e-mail in the secondary or follow-up phase of the research.

In addition to interviews with specific teachers, data collection was triangulated through a variety of methods. As a trainer on the National Science Education Standards training for teachers in this district as well as a consultant in the curriculum re-examination process, I was able to directly observe how teachers reacted to the national standards as well as how they utilized them in this re-examination. Document analysis also contributed to the overall interpretation of this process. Teacher concerns statements regarding the implementation of state standards following a district professional development related to these standards provided further data for the analysis of state standards impact on the utilization of national standards.

It should also be stated that I am a "former native" of HMS, having taught sixth grade science there for six years from 1989-1995. Both my personal and professional contacts in the school district facilitated my access to participants as well as influenced my interpretations of the data. I saw this as an asset which could contribute to a more rich and accurate description of the culture of the school and district. Nonetheless, bias was a concern which was dealt with through peer debriefing sessions in which I discussed the study as it progressed with a colleague not intimately familiar with the setting. This colleague confirmed many of my interpretations of the data as well as provided insights which forced me to examine new issues and perspectives. In addition, member checking as mentioned above provided an opportunity for participants to evaluate my interpretations of their perspectives. Of the four teacher participants, only two were known personally by me before the study as was the secondary curriculum coordinator.

Data Analysis

Grounded theory techniques were utilized to develop an interpretation of national standards resource utilization in science education reform. Data analysis was primarily an inductive process in which transcriptions were deconstructed, coded, and synthesized using conceptual themes (Strauss and Corbin, 1990) . Relationships among concepts were examined and described, ultimately leaded to an interpretation which was grounded in the data. HyperResearch software assisted in data analysis. Source triangulation of the data occurred by matching common themes found in interview transcripts with emergent themes from

other data collection points such as field notes and document analysis. Data analysis was an ongoing process occurring both concurrently with data collection and after data collection. Insight gained through data analysis guided further data collection. The use of an emergent research design, responsive to the key issues which arose in each interview and field experience, was in keeping with the tenets of naturalistic inquiry laid out by Lincoln and Guba (1985).

Context of Study

Sites

Ten years ago, a traveler driving through the city of Hadleyburg may have barely noticed the quaint little town set about five miles off the highway. Passing by the city limits sign, our traveler might not have taken note that the town's population had not yet exceeded 5,000 people. If our friend stopped for directions, it's quite likely that the answer would have begun with, "Well, first go to the stoplight downtown . . ." When there's only one stoplight, it's fairly easy to orient oneself.

Today, Hadleyburg is a very different city and the one term that best epitomize that difference is growth. In less than a decade, the city of Hadleyburg has tripled in size, as has the surrounding school district, and stop lights are popping up everywhere. In that ten years, Hadleyburg Independent School District has added at least one new school campus every year and sometimes two or three. No longer would one classify Hadleyburg ISD as a small rural district. Both the town and the school district have now become part of the suburbs. The growth in Hadleyburg is similar to that experienced by many Central Texas towns in the last decade. High tech companies are moving into the region by the score and bringing with them thousands of young families and children. Though Hadleyburg has grown tremendously over this time period, the school district has consistently maintained a reputation for excellence. Area real estate agents often include "Hadleyburg schools" in their advertisements to lure young families interested in high quality schools.

Hadleyburg Middle School was the first middle school in the district and serves approximately 1,000 students in grades 6-8. A little more than one half of the students are white, about one quarter are

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Hispanic and less than one fifth are African American. About 15% of the students are classified as economically disadvantaged. Students at HMS, as well as other middle schools in the district, have consistently performed well on the Texas Assessment of Academic Skills (TAAS) in science. This state standardized test is a multiple choice, instrument which primarily tests science process skills. It is administered at the eighth grade level. In the 1996-97 school year, 93% of the eighth grade students taking the test at HMS passed. This is in comparison to an overall state passing rate of 84.6%.

Hadleyburg ISD prides itself on having one of the highest administrator to student ratios in the area. Though it is a 5A school district, the largest classification by Texas standards, it does not have curriculum coordinators for each subject area but rather one elementary coordinator, one secondary coordinator and one overall curriculum director. Three years ago a mathematics specialist was hired to coordinate that program. However, he was also given responsibilities for coordinating all district testing, such as the TAAS and AP exams, acts as the district truant officer, and in theory coordinates the science program as well. In reality, the responsibility for coordinating the science program often falls back on the secondary curriculum coordinator. As a result of this administrative structure, the science teachers in HISD have operated with a good deal of autonomy and very little direction from central administration for many years (Fletcher, 1996).

In the summer of 1997, the state of Texas adopted a new state framework for science education called the *Texas Essential Knowledge and Skills*, or *TEKS* (Texas Education Agency, 1998). Similar frameworks were adopted for other subject areas such as mathematics and language arts as well. Unlike the *NSES or Benchmarks*, the *TEKS* are mandatory and will be linked to a state-wide accountability system. In the past, Texas middle school science teachers were mandated to follow a list of essential elements at each grade level which were basically process skills. No particular science content knowledge was specified to be taught at certain grade levels. Middle school teachers and districts could determine the placement of content independent from recommendations by the state. In addition, the TAAS was designed to measure skill acquisition, not specific science content. With the adoption of the new science *TEKS*, HISD, like many other districts across the state, is re-examining its science curriculum in order to insure alignment with the *TEKS*. Initial exposure to the *TEKS* began in a professional development day for secondary science teachers

at the beginning of the fall 1997 semester. More in depth examination of the science *TEKS* continued in a professional development day held at the beginning of the spring 1998 semester.

After this introduction to the *TEKS* for all science teachers, a small group of teachers consisting of each department head at the three middle school campuses and the two high school campuses was brought together to begin a re-write of the curriculum. Both the secondary curriculum coordinator and the math/science coordinator participated to some degree in this two day process. In addition, I was asked to participate due to my training in the *TEKS* and general knowledge of reform trends in science education. This work session began an ambitious process in which the entire 6-12 science curriculum would be developed on-line. Eventually, HISD intends to provide teachers with not only a scope and sequence but specific lesson plans, resources, and assessment tools for every topic in the science curriculum. This attention to the specifics of the science curriculum is a major departure from the previous laissez faire approach to science that administrators in HISD have taken in the past (Fletcher, 1996). During the summer of 1998, a curriculum writing team of teachers representing each grade level will be assembled for approximately one week in order to address this task.

Past research with HISD middle school science teachers indicated that although they claimed almost no familiarity with national standards documents by name, they generally agreed with many of the basic tenets of reform which national standards espouse (Fletcher, 1996). These common principles include the goal of scientific literacy, the need for national standards, equity, inquiry, constructivism, cooperative learning, and relevancy. Teacher support for a spiral/thematic curriculum in which a "less is more" approach is utilized was the weakest. In interviews, teachers cited concerns relating to limited teacher background and apprehension that the district would not provide adequate time or training to implement it effectively as the most major barriers to adopting this type of instruction.

Morgan ISD shares many similarities with HISD. Formerly a small rural district, it now serves nearly 16,000 students due to rapid growth and consolidation with other surrounding smaller districts. Morgan Middle School, previously Morgan Junior High School, also has a student population of approximately 1,000 sixth to eighth graders. The ethnic composition of the MISD student body is slightly more diverse than that of HISD with Whites representing 41%, Hispanics 32%, African Americans 24% and

Asians 3%. Science TAAS scores for MMS or also slightly lower than those of HMS at 85% passing for the 1996-97 school year. This is approximately equal to the state mean passing rate of 84.6%. The most noticeable demographic difference is in the percentage of students classified as economically disadvantaged. MISD has over twice the percentage of economically disadvantaged students (36%) as HMS (15%).

Morgan ISD is a member of the Urban Systemic Initiative based in San Antonio. For several years the USI has been providing leadership, material resources and professional development to participating school districts to assist them with science and mathematics education reform. The American Association for the Advancement of Science's Project 2061 also houses a School-District Center in San Antonio and has contributed significantly to the USI efforts regarding professional development.

Participants

As mentioned before, although the middle school science teachers in these districts are joined by many similarities, they each bring to the profession unique experiences which have impacted their perceptions of national standards in science education. Especially key to this study is the degree and quality of previous exposure and training each of these individuals has had regarding national standards. The following section will briefly profile each participant in order to provide the reader with a context for interpreting their perceptions.

Kathy is the science department head at HMS and a seventh grade life science teacher. This is her sixteen year teaching science, fourteen of which have been spent in HISD. She has taken on leadership responsibilities in both her school as department head and in the district through committee work. She received her M.A. in science education approximately ten years ago and has been a member of science teacher professional organizations off and on throughout her career (NSTA and Science Teachers' Association of Texas). She has attended state science teacher conventions off and on as well.

Kathy's exposure to the national standards has been very limited. She originally purchased the *Benchmarks* book because she thought the content benchmarks in it would eventually becomes mandatory. Her initial reaction to the grade level benchmarks was that they were not rigorous enough. Her only exposure to the NSES came in a discussion session with the other science teachers on her staff after school

one day which lasted approximately one hour. Though she agrees with some of the basic tenets of reform described by national standards such as hands-on lessons, relevancy, and the goal of science literacy, in general, Kathy feels that national standards have little utility for the science teachers in Hadleyburg for two reasons: 1) no administrators have demonstrated a commitment to following national standards, and 2) teachers are held accountable for the TAAS, which isn't aligned with the content standards of NSES or *Benchmarks*.

Jim is a third year science teacher. This is his first year teaching in Texas and his first year at Hadleyburg Middle School. He enjoys teaching at this school and appreciates the collegial atmosphere. As a new teacher, he values the input and insights of the other science teachers on this campus. Sustained contact with the other science teachers can be more difficult for him at times however due to his spatial isolation from the other science teachers, most of whom are located together in science lab rooms on the other side of the building. Jim is eager to expand his knowledge about teaching and education and will begin graduate work this summer in educational administration. His experience with national standards documents is very limited and entails a discussion of the emerging standards through undergraduate coursework and a cursory review of the National Science Edueation Standards on-line by himself. Last semester he coached and also taught eighth grade science. At the time of our interview, he was unaware of any training related to national standards that had occurred at his school and had not perceived any emphasis on national standards from his peers or administrators, either in his school or at the district level. On the day that the rest of the science department met to discuss the NSES after school last semester, Jim was involved in coaching and did not attend the meeting. Although he has a limited formal exposure to national standards in science education, he is aware of and in agreement with some of the guiding principles espoused by national standards with regard to content and pedagogy. He supports the inquiry method of teaching science in which children are actively involved in doing science and applying scientific principles. He also agrees with the less is more philosophy with regard to content as well as the notion of integrating the scientific disciplines more at each grade level. Although he agrees with these ideas, he does predict that teachers may have difficulty realizing these goals due especially to the limited content knowledge teachers often have across disciplines. He found

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it difficult to identify any key principles related to other standards such as assessment, program, and system when asked about them specifically in an interview.

With regard to using the national standards as a resource, Jim feels that they are not really necessary in a state like Texas which has a very influential state educational establishment and has recently issued state standards in the form of the *TEKS*. Although it would probably beneficial to look at them as a reference, and possibly compare them to the *TEKS*, teachers in Texas are expected to utilize the *TEKS* as a guideline. If national standards align with what the *TEKS* are saying then that's all the better but if they do not then they won't be very helpful because he is accountable for the *TEKS*. In addition, Jim asserts that real improvements in science classrooms will not come as a result of a mandate from outside the classroom. Real change will happen only if the classroom teacher decides to pursue reform himself, regardless what the standards or the *TEKS* say. However, if other individuals at his campus or in his district placed an emphasis on becoming more aware of the national standards, he would be willing to explore them further.

Lynn is a sixth grade science teacher who is currently spending her first year in this district at Hadleyburg Middle School. She has thirteen years of experience teaching in a different district and became a teacher after an earlier career as a medical technician. In her previous district, Lynn had several leadership opportunities with regard to science curriculum through committee work but as yet has not been involved in these types of committees in Hadleyburg ISD. She belongs to three professional organizations, at least one of which is directly related to science teaching, NSTA. She describes herself as a life long learner who is never satisfied. Though she is not actively seeking a graduate degree at this time, she has taken numerous graduate level courses related to improving both her science content knowledge and pedagogical techniques. It was through one of these courses at Southwest Texas University that she received her first exposure to national standards documents from Project 2061. In this course, which included a good deal of modeling of hands-on activities, the professor utilized both *Science for All Americans* (1990) and *Benchmarks for Scientific Literacy* as resources.

Lynn credits her coursework at Southwest Texas University for her positive attitudes toward using national standards. This long-term exposure, and in particular the modeling of standards-based practices that accompanied it, convinced her of the utility of documents such as *Benchmarks* for examining her own

pedagogy. She has utilized her understanding of national standards primarily as a philosophical guide but also practical resource when teaching specific concepts.

Molly is an eighth grade earth science teacher with seventeen years of experience, fifteen of which have been in Hadleyburg. Although she does not consider herself a leader in the district, she attended a one day workshop on the NSES as a representative from HMS. She had originally thought she would be moving out of the area and therefore had not yet completed the six hours worth of summer professional development required by the district to qualify for comp days during the following school year. Attending this workshop helped her to complete this requirement.

She stated in our interview that she is unsure of how much longer she will remain in teaching. She feels there is very little connection between the national standards and the reality of classroom teaching. She is also inclined to believe that those who wrote the national standards documents have been out of the classroom for too long and lack a realistic perspective regarding today's student populations. In general, she sees national standards as something that is being imposed on teachers, not something that teachers could use a resource to empower themselves. Though she is willing to learn more about national standards and is open to the possibility that their recommendations may improve student performance, she feels her plate is full with all of the other requirements her job places on her and lacks the motivation or the time to explore national standards further on her own outside of school. While some may discount the importance of including the opinions of a teacher who appears ready to leave the profession in a study such as this, it seems likely that the characteristics which describe Molly are reflected in a small but significant number of classroom teachers and therefore must be considered.

The secondary curriculum coordinator, Lisa, is an extremely well respected administrator throughout the district. She is known both for her intelligence and her tenacity at tackling and solving problems. Though the district has hired an individual to coordinate both the math and science curriculum, Lisa often takes responsibility for the science curriculum coordination when she feels she can provide effective assistance. The science teachers I have spoken with appreciate the leadership she provides them. Lisa was one of the individuals most capable of articulating the major principles of national science standards in Hadleyburg, even though she has never taught science. She began to learn more about the

national standards because she knew that the district would be re-examining it's science curriculum and she had a personal desire to be well informed regarding contemporary, research-based recommendations. As a result, she obtained a copy of the *NSES* and studied it. Her own knowledge of and interest in brain research and cognition supported many of the basic tenets of science reform such as constructivism and inquiry-based lessons.

Michael is the science department head at Morgan Middle School. He has twenty three years of teaching experience and has spent thirteen years in Morgan ISD. He considers himself a leader in both the school and the district with regard to the science program. His training on the Project 2061 materials consists of approximately 4 days of workshops over a two year period. He has not received training on the *NSES* but would like to find out more. Michael stated that he used *Science for All Americans* and *Benchmarks* a few years ago to redesign the current science curriculum but he hasn't looked them since then. He intends to use them further this summer when Morgan re-examines its science program in order to align it with the *TEKS*.

Sean is a sixth year science teacher at Morgan Middle School. Teaching is a second career for him. His previous experiences was in the business sector. He received training on national standards through an extensive eight day program provided by the USI. Morgan Middle School was represented by himself, a math teacher and a technology teacher. This training addressed the Project 2061 materials, the *NSES*, and the *Curriculum and Evaluation Standards for School Mathematics* (1989) from the National Council of Teachers of Mathematics. A good deal of time was spent discussing the research upon which these documents were based and the connections between them. Sean has an extremely favorable attitude toward the national standards and was able to clearly articulate all of the basic principles reflected in these documents. He has used *Benchmarks* in particular as both a philosophical and practical reference tool in his classroom. He intends to utilize them further this summer when the district looks at aligning it's curriculum to the *TEKS*.

Findings

A number of themes emerged in this study that provide insight as to how and why teachers may utilize national standards in science education.

1. First impressions made a difference.

Though the teachers in Hadleyburg expressed support for most of the basic tenets of reform outlined by the standards (constructivism, inquiry, the goal of science literacy for all), those with little exposure to the national standards were most likely to focus almost exclusively on content standards and benchmarks when they heard the term national standards, not overarching principles. In the absence of meaningful discussion regarding the research which supports these content standards, teachers with the least exposure to national standards were likely to question the placement of concepts at certain grade levels and discount the overall quality of these documents as a result. For example, though Kathy purchased the *Benchmarks* book when it was first published she hasn't really used it as a resource because she felt the content standards were "watered down."

> Interviewer: Why did you buy *Benchmarks*?
>
> Kathy: I actually purchased it for the department because I thought it was going to end up being something mandatory that we were going to have to do. I basically wanted to see what they did have as national standards from that program.
>
> Interviewer: Why haven't you used it? You indicated that you really hadn't ever looked at it. Can you give me. . .
>
> Kathy: Well I looked at it and, the same thing, a lot of the stuff that they have as benchmarks for our kids, our middle school kids, are stuff that I think they have probably done in elementary. I think they are a little watered down for them.

In contrast, those with more training in national standards such as Sean felt the research base supported this "less is more" approach to designing curriculum, but they would not have realized that if they had not been given extensive training which addressed this research.

> Interviewer: So you do need some background training, it's not like you can just pick it up?
>
> Sean: Evidently. The first two days of that seminar that I went to last summer, I didn't have any idea what they were doing. It was only after we got through with that groundwork, then they

started explaining that groundwork in terms of the national standards, then it started to click. If I was thrown that *Benchmarks* and said what is your impression. Look through it and . . .

Interviewer: So you need the extensive on-going professional development?

Sean: You need the study background support, to support your understanding of the national standards. It's just, just to take the standards, this is what the studies have shown to be true, what were the studies that they used to prove that they are working? It helps to get it from the experts who have done the studies and. . .when you see that, how it correlates back to the standards, because the standards are based on the research, then you go, okay, now I see where it's all coming from. It's easier to grasp the whole concept of standards in light of the research that has been done over the past fifteen or twenty years.

Clearly, the negative first impression expressed by Kathy and others in Hadleyburg with limited training in national standards affected their interest in learning more about the national standards and thus their impressions of their value to classroom teachers. The impact of this negative first impression appears then to be profound. Kathy has no real interest in learning more about national standards as a result. Similar attitudes were expressed by other HMS teachers with limited training in national standards. In contrast, because Sean was exposed to more than just the recommendations of the standards but the research that supported them as well, he developed a much more favorable impression of the content standards which did not limit his exploration of other aspects of the standards. Lynn developed the same favorable impression as a result of hertraining using Project 2061 materials over an entire summer course.

2. The factors which influenced a teacher's willingness to utilize national standards as a tool for reform changed as a function of their exposure to national standards.

The most influential factor for the teachers in Hadleyburg with little training in national standards was that of subjective norms. Teachers repeatedly stated that the degree of emphasis placed on national standards by other significant individuals in their district played a major role in their decision not to utilize standards.

Jim: In school the people around you influence you greatly. Especially those teachers who've been teaching, doing it for 20 or 30 years. They're very influential. If they say Oh it's just some other national standards just put it in the filing cabinet who cares. That's very influential I think.

Interviewer: What kind of perceptions have you been given or have you gotten any from the other teachers?

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Jim: Oh sure, mostly through *TEKS*. Like I said before national standards are important, we need to look at it but it has not been looked at as specific or at great a length as the *TEKS* have.

Interviewer: So it's something that might be important but you wouldn't call it a high priority to the other staff?

Jim: No. It's important, but it's not an absolute priority because you have the *TEKS*. And you get standards to death. How many documents do you need?

Kathy expressed the same sentiment regarding her perceptions of a lack of priority from administrators:

Kathy: Of course if it comes from higher up that they need to be used we'll use them. But at this point no one has said anything to us about them except for Molly (a fellow teacher) said she needed to keep up after school one day.

When the curriculum coordinator was interviewed she was surprised to learn about this perception of a lack of emphasis on national standards because she felt the connection between *TEKS* and national standards was focused on in the district training of *TEKS*.

Interviewer: Many of them have said that they really don't have a great interest in using them and one of the reasons they don't really see them as being useful is that there isn't really this push from an administrative level or a priority from an administrative level.

Lisa: That's interesting because on the very first PD day, August, one of the things that they were required to do was, we distributed to them, copies of national standards. They had to sit down and do kind of a peer review. Now, obviously there was not much retention.

Interviewer: Right. Now, when you say copies of national standards?

Lisa: It was just a summary sheet. One of the points that we were really trying to make with them was that the shift in science reflected in the *TEKS* is coming from national standards. Now we were also tying, and maybe this is where the national standards got lost, we were tying national standards and AP exams, as far as places to look. And the truth is the AP exam just is not a good model. But that is where their attention was.

This concern with subjective norms was tied very closely to accountability issues as well.

Interviewer: What do you say then would be the number one factor, or top three or what ever, that are influencing you either to use or not use national standards as a tool?

Molly: I think it's going to be expected of me at some point.

Interviewer: So that would influence you to use them.

Molly: Right. I think it will be a necessity all most. I'll be maybe even graded so to speak. Evaluated on that at some point down the line.

Interviewer: So the likelihood of you using standards would probably be more based on if somebody in administration said this is what we need to do. Is that a good way of putting it?

Molly: Yes

In contrast to teachers with very little training in national standards, teachers with greater training, though still influenced by subjective norms, appeared to place more value in their own attitudes toward national standards documents as the factor which encouraged them to use them as a resource. For example, though Lynn stated that she had perceived little emphasis on national standards by Hadleyburg administrators or co-workers in the short time she had been employed there, and that she felt accountable for covering the *TEKS*, she still utilized her *Benchmarks* book quite often because she found it personally valuable.

Interviewer: You see your districts document as being very valuable to let you know where they're coming from and where they are going. Would you refer to a national standards document to find out that kind of information or would you rely solely on this document?

Lynn: Well I feel like the district's going to hold me accountable here (referring to district document) but certainly I would see what suggestions are in here (*Benchmarks*) so I could build, because this still leaves me open to how I want to teach the different concepts and content. So then I would, this (*Benchmarks*) is my resource, this is freedom I so called have, to build a better curriculum that's workable for me and my students.

Sean, who perceived a great deal of support for using national standards from his administration, expressed this balance between attitude and subjective norms most succinctly.

Interviewer: Okay, so out of all of those things that you've talked about, what is the number one reason why you plan on using national standards as kind of a guide for reforming your own practice. . .

Sean: Wow, that's a good one. Uh, number one, I think it has to be a personal belief that you believe that it is the right thing to do and having administrative and upper level support doesn't hurt.

The data also indicates that past experiences with much balleyhooed reforms which fizzled • influenced some teachers to act on their first impression and not invest too much time into this new idea until they were convinced of it's value.

Interviewer: Do you think they (national standards) are worthwhile for a teachers to learn more about?

> Kathy: I think that at this point in time, it's somebody's baby and they're working on it and eventually that person is probably going to be gone and the next person may not care about as much. I think it's just one of those things teachers tend to end up riding out. They ride out the current hype.

This type of "been there, done that" attitude may have been traditionally characterized as obstructionist by many researchers. In contrast, I propose, like Gitlin and Margonis (1995), that this cynicism clearly indicates a significant political insight. As such, Kathy's response to national standards can be seen as making good sense. Based on her previous experiences with cyclical reforms that started out with a good deal of hype but eventually fell by the wayside and the lack of explicit administrative support for utilizing national standards, she has no reason to believe that investing her time in learning more about national standards will produce significant or long-term changes in her students' science experiences. The data indicates that the teachers with the least amount of exposure to national standards are clearly exhibiting signs that they are still in the first stage of Fuller's Stages of Concern. Until they are convinced that the personal investment of time and energy they must make to implement standards-based reforms will be supported by follow through in other parts of the system, these teachers are not likely to see the value of learning more about them.

> Molly: I guess if I was more familiar with them then I guess I would be able to see how they fit into what I am doing now and how I could change the way I do things to fit them and that would take some motivation on my part which right now I don't have. It's not that I don't want to do what's good for the kids, it's just that the time that there is, I don't have that time.
>
> Interviewer: Right. It's just not going to fit on your plate.
>
> Molly: No. If it's something that we do, go through at school, I can do that but if it's something that I'm expected to do on my own I just. I hate to sound like I don't care and that's not it. It's just that right now I can't.

3. The influence of national standards thus far appears to more philosophical rather than practical, especially for those with the least amount of exposure to them.

Teachers who claimed little knowledge of national standards or had a negative attitude toward them based on their first impression still tended to agree with some of the major principles touted by national standards such as the goal of scientific literacy, relevancy, vertical alignment of curriculum and, to a lesser

extent, inquiry. While these teachers may disagree with the specific placement of content at different grade levels, they have endorsed some of the other overarching tenets of reform which the national standards espouse. Because many teachers in Hadleyburg already feel that they are teaching successfully in a manner aligned with the standards the necessity of referring to national standards in more detail is played down.

Interviewer: Would your course be different if it were aligned with content standards?

Jim: I'm going to say no.

Molly expressed the same sentiment when describing the reactions of teachers toward the *NSES* on the day they discussed them after school.

Interviewer: What were there reactions?

Molly: Fairly negative. Why do we have to do this? And in some ways they were I think similar to mine. Look they don't even bring in the parts of the atom until ninth grade and I can't remember if that's exactly what it was but we're already doing this in sixth grade so you mean we can't do this anymore and that kind of thing. And looking at I think it was, doesn't one of them have to do with the way teachers instruct, we do this anyway, we already do this. Which is one thing that as we were kind of going through those this summer I was thinking we already do this. We try to make things inquiry based somewhat.

While the teachers with more exposure to standards were able to give examples of when they had actually referred to the documents in designing a unit or lesson, they generally described the impact of national standards training by focusing on how the documents have helped them philosophically rather than with teaching specific concepts. Lynn focused especially on the idea of relevancy in the classroom.

Interviewer: How have you used them thus far in your own practice?

Lynn: Well just the relevancy. Like the lab today is just a rotation lab and the kids go around and they're putting down the chemical formula and the chemical name and whether it's a solid, liquid, or gas. But trying to get them to see that chemicals, everything is a chemical and has a formula. We might not have discovered them all but eventually, everything is made up of these atoms. So I'm trying not to just pull chemicals out of the storeroom so I brought in antifreeze and the Zircon, kids are giggling over that, vinegar, ammonia, nail polish remover and that kind of thing.

Interviewer: So this has helped to remind you about the importance of relevancy?

Lynn: Right, relevancy

Interviewer: Is there any thing else that this has helped you to do in your classroom that you might not have done had you not been exposed to *Benchmarks*.

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> Lynn: Well certainly the issue of technology, math, and science I have really worked at trying to tie all three of those things in. And even with my limited access to computers that part has. I use a laser disc which then because we don't have a hood I can at least expose them to some of the experiments that I wouldn't be able to do. I try to pull a variety of techniques in keeping the kids interest up.

In addition to relevancy and technology integration, Lynn also mentioned that she had increased her efforts to make students more independent learners in her classroom and was constantly working to improve the problem solving focus of her lessons. She shared with me a number of activities that she incorporated into her class which were influenced by the principles of the *Benchmarks*.

Sean also indicated that while he did use *Benchmarks* at times to learn what misconceptions students might have about a particular topic, his own practice has changed in more fundamental ways as well.

> Interviewer: I know in benchmarks there's a section on research notes which discusses some of the common preconceptions or misconceptions students have when they deal with this at different age levels. Do you find yourself looking at that?
>
> Sean: Oh, yeah, and ask the students, what are your perceptions in this particular area? I get lots of questions and I find there are many misconceptions about particular topics in science. So I ask them, well, why do you believe that way to try to get an understanding of where they are coming from.
>
> Interviewer: Have you found that you do that more as a result of your training here?
>
> Sean: More.
>
> Interviewer: Did you do that before?
>
> Sean: To an extent, but not as much. When you are not aware that there are, there are studies that show there are misconceptions, heavily out there, you don't think about asking the questions to find out what the misconceptions are.
>
> Interviewer: How has your own personal practice changed as a result of your training on national standards with USI?
>
> Sean: It's forced me to look more critically at what I do in the classroom, not necessarily what I cover but how I cover it, how I get the students involved in the classroom, what skills are really important and really focus on those skills and those abilities that will allow that student to be successful.

Sean's point that national standards have changed how he covers material, not necessarily what material he covers illustrates the difference between teachers with extensive training and those with limited

training. Those with extensive training saw the national standards more as a collection of guiding principles rather than a curriculum guide. Those with limited training perceived just the opposite.

An additional barrier to a more thorough utilization of national standards by teachers without the opportunities for extensive training may be this philosophical rather than practical focus. Though the national standards are effective for providing a theoretical foundation upon which to base a science program, and as mentioned before, teachers in Hadleyburg perceive that they are aligned for the most part with the major principles of the national standards, national standards documents fail to provide teachers with the technical details they need to translate concepts like inquiry-based instruction into specific teacher practices. Analysis of teacher concerns statements after a training session designed to acquaint Hadleyburg teachers with the *TEKS* indicates that over half of the district's science teachers are very concerned with developing actual lessons based on the principals, not on learning more about the theoretical foundations of the national standards. This difficulty became most apparent during the curriculum planning session between all of the secondary science department heads. These five individuals met for two days in order to begin the process of redesigning the curriculum to align it with the new *TEKS*. As we got to down to actually writing sample lessons which reflected true inquiry, the department heads began to realize that many teachers would have difficulty designing lessons that were more than just hands-on but actually inquiry-based. Field notes from this work session illustrate this dilemma.

> We also struggled with transferring the notion of inquiry oriented pedagogy to actual lesson development. Although I have not directly observed all of the teachers in the district, my previous research involving its middle school science teachers and my subsequent interviews since then indicate that these teachers agree that hands-on lessons are for the most part effective and motivating. However, department heads here acknowledged that although many of them use hands-on activities, these activities are not necessarily inquiry-based. For example, they may be doing lab experiments to verify the gas laws but the students are not necessarily constructing their own understanding of the gas laws by doing hands-on. They are merely verifying what they have already been told by the teacher and textbook. The department heads felt that planning lessons centered on inquiry was an area in which they needed some specific guidance and that it would take a long time and a lot of effort to rethink their traditional way of presenting science content.
>
> A graphic example of this struggle occurred when the high school department head returned at lunch on the second day with an example of a series of lessons she had produced for the biology course cluster on taxonomy. These lessons taught students how to build a taxonomically representative wildflower collection. Although this was very hands-on, it did not necessarily require students to construct their own classification scheme but rather to collect samples which fit some pre-existing classifications. Though students might eventually do this as a summative activity, in a lesson focused on inquiry, they would be expected to explore the issue on their own terms first

and then postulate possible solutions that might test (the usability of their classification schemes) later.

This struggle teachers had with translating in practical terms the recommendations of the *TEKS* and thus the national standards was another likely indicator of why some of them felt that national standards documents are not worthy of their time and efforts. Though these documents repeatedly emphasize the importance of inquiry and the *NSES* provide some illuminating vignettes, none of them as yet provide teachers with a template for designing their own inquiry lessons. National standards emphasize the importance of the teacher as professional. They offer a vision of what a professional teacher should be doing both within the classroom with regard to pedagogy and beyond the classroom with regard to professional growth. They describe the conditions that must be necessary for the teacher to be treated like a professional. However, teachers are both professionals and technicians. As professionals, they must understand the underlying principles and assumptions that guide their practice, but as technicians they must translate these principles and theories into explicit tools and techniques to be used in the classroom. At this stage, teachers might not see the national standards as offering much assistance to them in their role as a practitioner. Though these documents provide examples of what an inquiry-based classroom should look like as an end product, they provide no models for teachers that are just beginning to grasp the implications of inquiry-based instruction to follow in designing specific lessons. Even NSTA's *Pathways to the Science Standards* (1996), a book specifically billed as a guideline "for moving the vision into practice" fails to address this issue. This lack of a basic model which can assist teachers in designing inquiry-based lessons may contribute the sentiment teachers often express when confronted with a new theory, "That sounds real good, but what do I do Monday morning?"

4. State standards which deal primarily with content tended to dominate the concerns of those teachers with little exposure to national standards.

As a result, these teachers were unlikely to be interested in learning more about standards other than content. Though Hadleyburg was examining it's science program in order to align it with the *TEKS*, teachers expressed little interest in looking at national standards as a resource for judging the quality of other

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aspects of the program besides content. When Kathy was asked to describe why she didn't envision herself utilizing the national standards, she stated:

> Kathy: The time factor and the concern with the *TEKS*. Right now that's everybody's big concern. And I can't blame them. The workshop we had last week, a lot of people were really, you could just feel the level of concern. We're certainly not going to want to hit them with anything else at this time. They'd bail for sure.

Jim also echoed this sentiment.

> Interviewer: You haven't used any national standards document as a resource for reflecting on or evaluating your practice. Why?
>
> Jim: I haven't had the need to use National Standards. Texas standards have provided ample guidance for not only myself, but also for those teaching around me.

These teachers saw little value in personally becoming more acquainted with national standards for two reasons: 1) If national standards <u>are not</u> aligned with state content standards, then they are a waste of time because I am accountable for state standards, or 2) If national standards <u>are</u> aligned with state content standards then studying them would be redundant. Once again, due to their focus merely on content standards, these teachers were most likely to discount the utility of standards other than content in the *NSES* or of portions of *Benchmarks* such as the Research Base that might help them to address their struggles with the *TEKS*.

For those teachers who had more exposure to national standards, the principals which connect national standards to the *TEKS* were more apparent. As a result, these teachers appeared far less anxious about transitioning from their current curriculum to one aligned with the *TEKS*.

> Interviewer: Do you personally see a connection between the *TEKS* and national standards documents?
>
> Michael: I think I see a definite relationship in there. Even though they are pretty quick to point out to the critics that it's really not there or something... Well considering the current trend is to do away with federal control, they would consider it bad if it felt like, okay, everybody is going to follow the same standards. Because they don't understand what standards mean.

These differences in attitudes toward *TEKS* alignment were clear not only from a individual perspective, but an institutional one as well. In Hadleyburg, the district which was not involved in a

systemic reform project and had not emphasized with its teachers national standards utilization, the administration was intending to pay a small group of teachers to rewrite the entire 6-12 science curriculum in just over a week. In Morgan, where the teachers were in the process of being gradually trained on national standards through the USI, the emphasis was on quality changes over time, not an instantaneous overhaul of the curriculum.

> Interviewer: So you see the examination of curriculum being a lot more of a gradual process rather than we have to rewrite the whole thing by. . .
>
> Sean: I don't think there's any way we can write it all in one. .
>
> Interviewer: And you don't feel that pressure from your administration?
>
> Sean: Not only that but we don't get it from USI.
>
> Interviewer: Okay.
>
> Sean: Feeling that more mistakes would be made if we tried to do it all at one time than working at it gradual. Otherwise we should have had all the science and math people at USI rather than work them in gradually. That just goes without saying. That's going to take a lot of work to do. Here we've been chugging along for how many years with the curricula that we have, you aren't going to change it overnight.
>
> Interviewer: Right.
>
> Sean: And people aren't going to change overnight. That's why we have to do it gradually.

Implications And Discussion

1. Short-term, one-shot professional development regarding national standards may actually do more harm than good.

Teachers in this study were initially skeptical of the rigor of content standards. For those than agreed with the standards, this agreement came only after extensive exposure to the research upon which these decisions were based or modeling of standards-based instruction. Without an opportunity to make decisions about the utility of the national standards informed by the research, teachers in Hadleyburg developed a negative first impression and discounted the utility of these documents as a whole. Rather than viewing them as a legitimate resource, teachers with only short-term training remained skeptical of their utility. Unfortunately, most current classroom teachers have not been given the opportunities for extended

training on national standards like those in Morgan ISD or Lynn in Hadleyburg. In fact, the program for disseminating the *NSES* in Texas, Building a Presence for Science, is designed to provide a full day training session to one teacher in every school. This teacher is then expected to go back to his or her faculty and train them. This is how Hadleyburg teachers were trained. If administrators do not support this campus-based effort with allocations of time and other resources, the training for most classroom science teachers is likely to be very similar to that experienced by the teachers at HMS: a short overview for about an hour after school. Those who provide professional development related to the national standards must then be responsive to the initial concerns of teachers regarding national standards and vigilant about avoiding the misconceptions this training may be developing in participating teachers.

2. Those who hold teachers accountable must demonstrate a commitment to standards-based reforms before most teachers will embrace them.

As described in the Concerns-Based Adoption Model (Hall, Wallace, & Dossett, 1973), implementation of a new reform will be most successful if leaders attend to the personal concerns of teachers during the initial stages of implementation. Since teachers with short-term training in national standards were often likely to cite the influence of external factors such as peers, administrators, or state accountability systems as their reason for not wanting to learn more, it is important to balance opportunity to learn more with support from other parts of the system, especially those parts which teachers feel hold them accountable. Because of many teachers' past experiences with failed reforms, the long-term success of national standards may rest not merely on simultaneous changes at all levels of the system, but actual pre-emptive changes to components such as accountability systems in order to demonstrate a good faith effort on the part of administrators, districts, and state agencies. Though this appears to contradict the now popular notion of "bottom up" reform, it seems that efforts must be made on the part of administrators and state leaders to rectify the mistakes of the past before the majority of teachers can be convinced to make the investment necessary to utilize national standards to reform their practice. As teachers learn more about national standards, they are more likely to use them as a guideline for reflecting on their practice because they "buy into" the principles upon which the national standards are based. Before this buy in occurs

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however, teachers must be convinced that the effort they expend to become more familiar with these national standards will be worthwhile in terms of long term peer and administrative support. As knowledge of national standards increases and buy in increases, teachers' concerns change and they are more likely to use national standards because they have positive attitudes toward them, regardless and quite possibly in spite of the support they receive from other parts of the system.

3. In order to maximize the effectiveness of documents such as Benchmarks or the NSES, training should focus on how each documents' component parts can be utilized by the classroom teacher.

It is apparent that national standards documents offer a number of untapped resources for science teachers. Classroom teachers can capitalize on these resources most effectively if they are able to see how these documents provide both philosophical and practical assistance. As a philosophical guide, national standards documents help teachers to focus on the goal of scientific literacy, constructivist cognitive theories, integration of the various science disciplines, etc. However, these documents can also be used by teachers as technical guides which can inform day to day decision making. For example, in *Benchmarks* teachers can refer to the grade-span comments for each concept heading which discuss what difficulties students might have with the concept and what their prior conceptions are likely to be. Cross-references to the Research Base chapter can further illustrate what the research actually has indicated about children's learning regarding a specific concept. These components of *Benchmarks* can be very powerful resources to assist teachers with reflecting on the experiences of their own students and making decisions regarding both the sophistication and sequencing of content. Until classroom teachers utilize this document in such a manner, the full potential of *Benchmarks* cannot be realized.

Though they were generally aware of both content and teaching standards, the teachers in Hadleyburg who had only short-term training in national standards were quite unaware of the potential uses of program standards or professional development standards. Even though they were initiating a complete overhaul of their current curriculum, it was unclear what criteria they planned to use other than state content standards to guide this reform. Not until the development of the mission statement by the department heads

did teachers appear to give thought to the basic principles upon which their entire district's program was based. The program standards of the *NSES* could provide a framework which can be used to judge more than just the particular content which is to be placed at each grade level but the coordination and coherence of the entire program as well. Future efforts to implement standards-based decision making in Texas schools, or any other state which already has specific standards for content, should focus on how teachers and administrators can use these documents to reflect on the entire science education program in their district, not just curriculum and instruction.

Conclusion

At the beginning of this study, I asked if teachers who are faced with the immediate pressure to produce students that can perform well on state standardized tests would simply ignore the array of fundamental changes advocated by national standards and focus only on the content of TEKS. Unfortunately, it appears that for some teachers with limited training in national standards, the answer is yes. The good news is that with adequate training in national standards and modeling of instructional practices that are standards-based, the teachers in this study chose to focus to a greater degree on standards other than content. They were also more likely to use these standards as guidelines for reforming their own practice than teachers with only limited training. But only a fraction of the science teachers in this country are likely to receive the type of high quality training that Lynn and Sean did. If the typical classroom teacher is to view national science education standards as a vehicle for real change, the majority of teachers, not just a few with extensive training, must be convinced that those who hold them accountable will support their efforts to implement standards-based reforms. It remains to be seen whether school districts and states will invest the necessary resources to do so.

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